# Biogeochemical Responses to the Removal of Maricultural Structures from the Eutrophic Lagoon (Tapong Bay) in Taiwan

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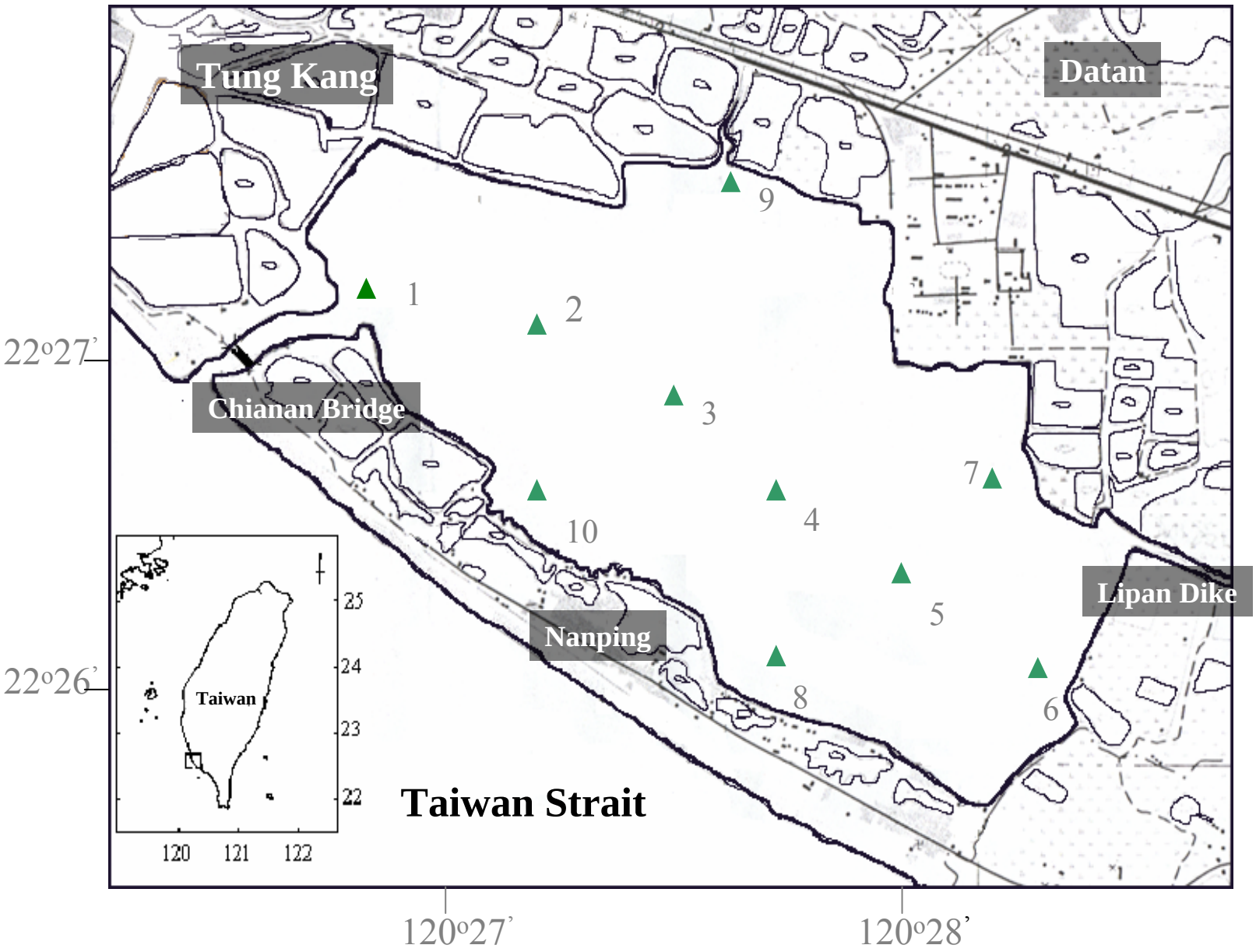
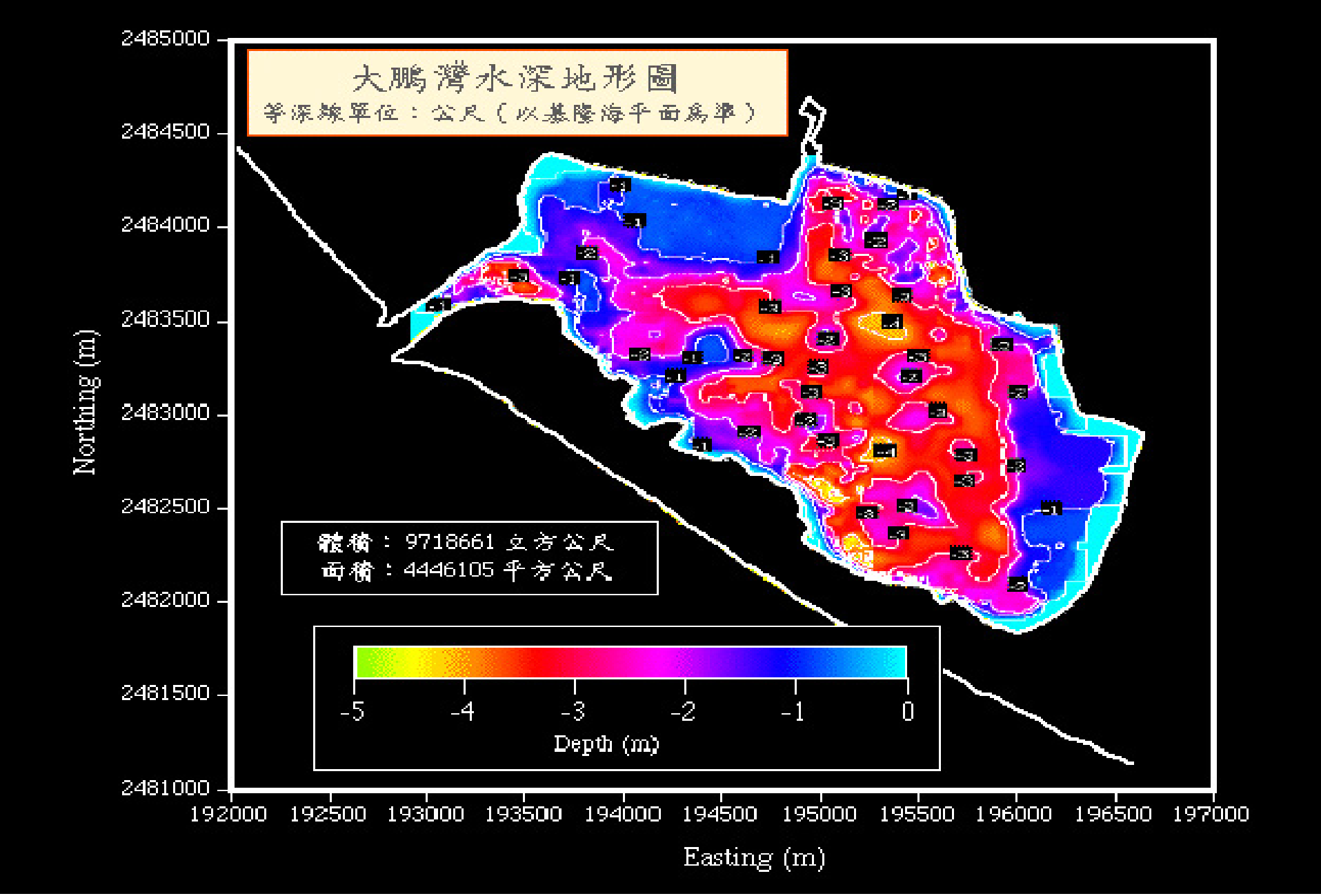

Tung Kang
Datan
Chianan Bridge
Nanping
Lipan Dike
Taiwan Strait
Taiwan
1
2
3
4
5
6
7
8
9
10
22°27'
22°26'
120°27'
120°28'
25
24
23
22
120
121
122




Provided by James Liu

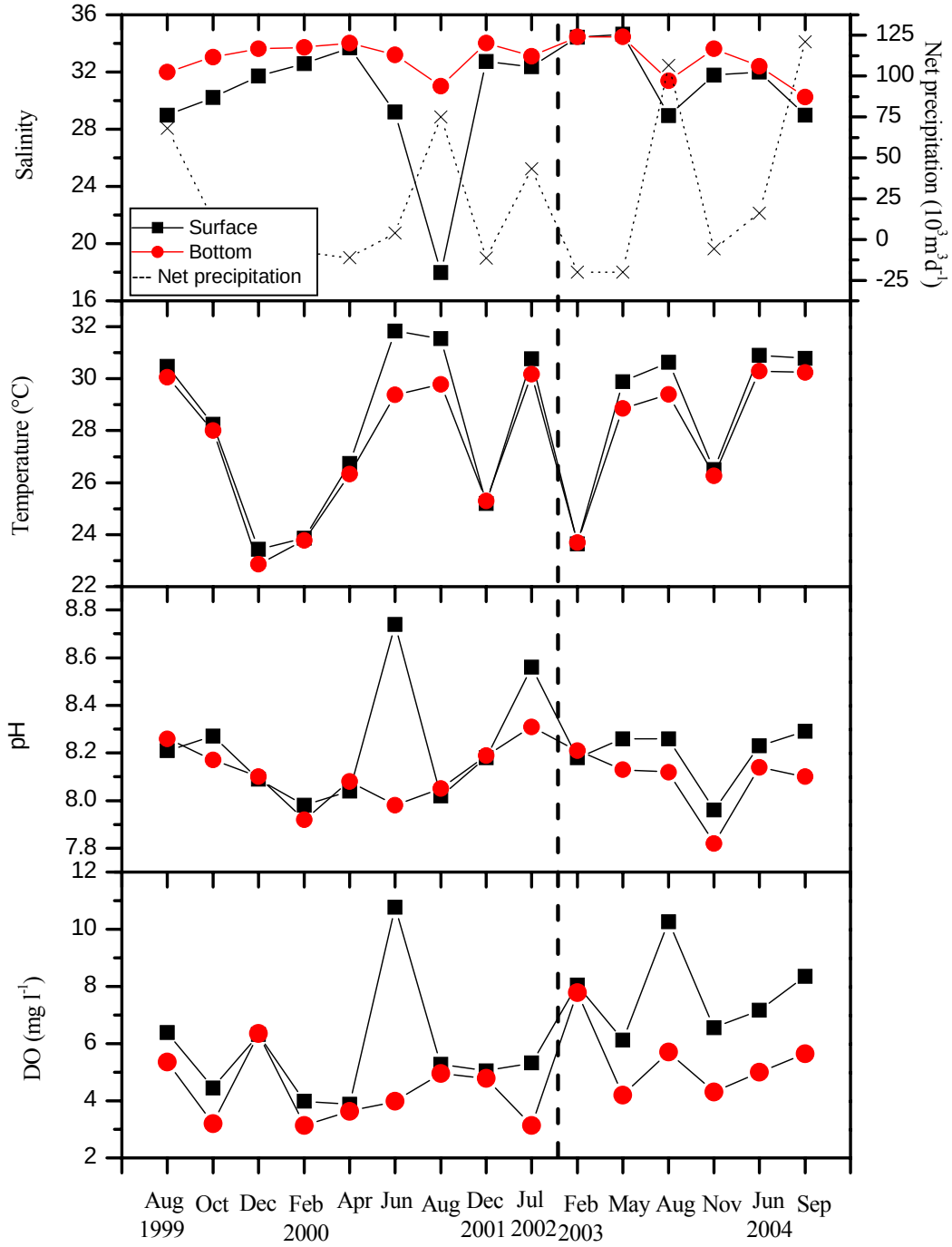
# Tapong Bay is an Ideal Site for Studying

Effects of Environmental Change on Carbon and Nutrient Dynamics and Ecosystem Functioning in the Coastal Zone

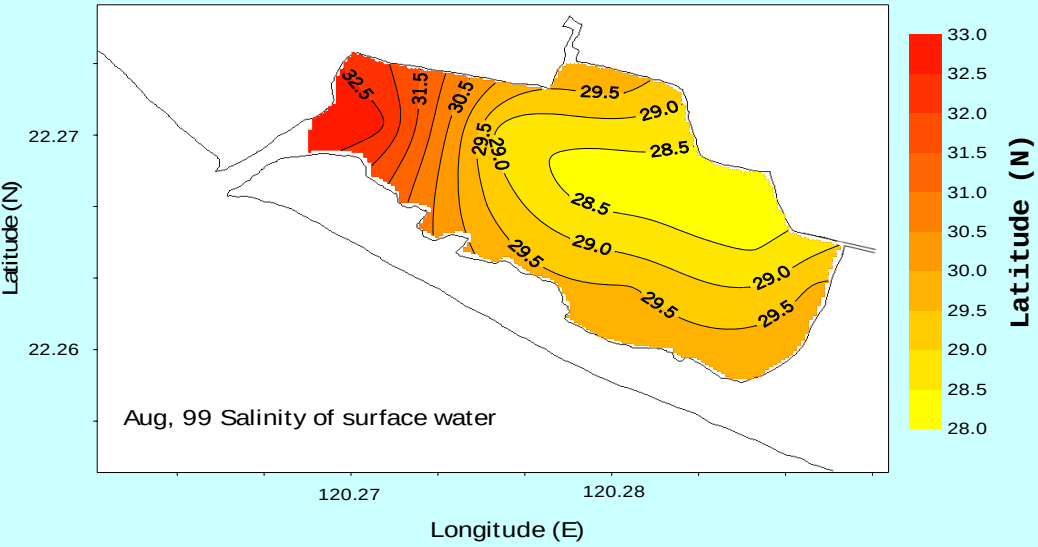
Before 2003, Tapong Bay was used mainly for mariculture, occupied largely by oyster racks and cage farming facilities

After January 2003, the surface structures were completely removed for developing to be a part of National Scenery Park.

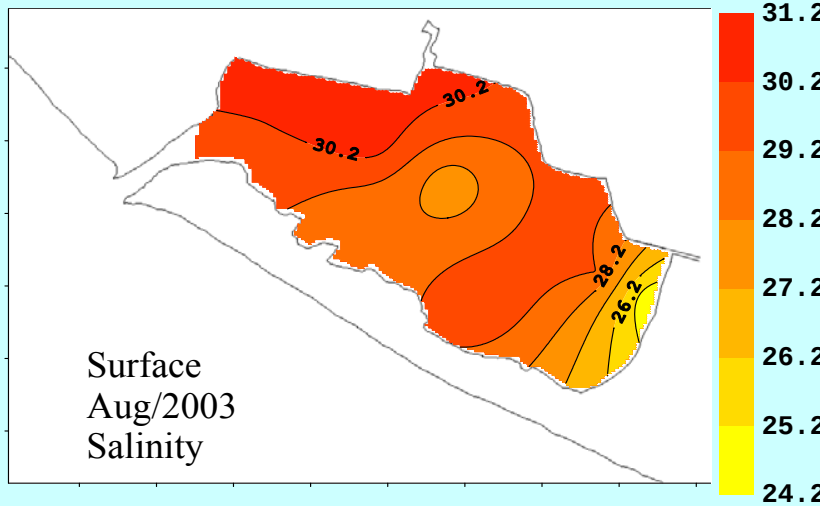
屏東 大鵬灣 / 陳柏林 攝影

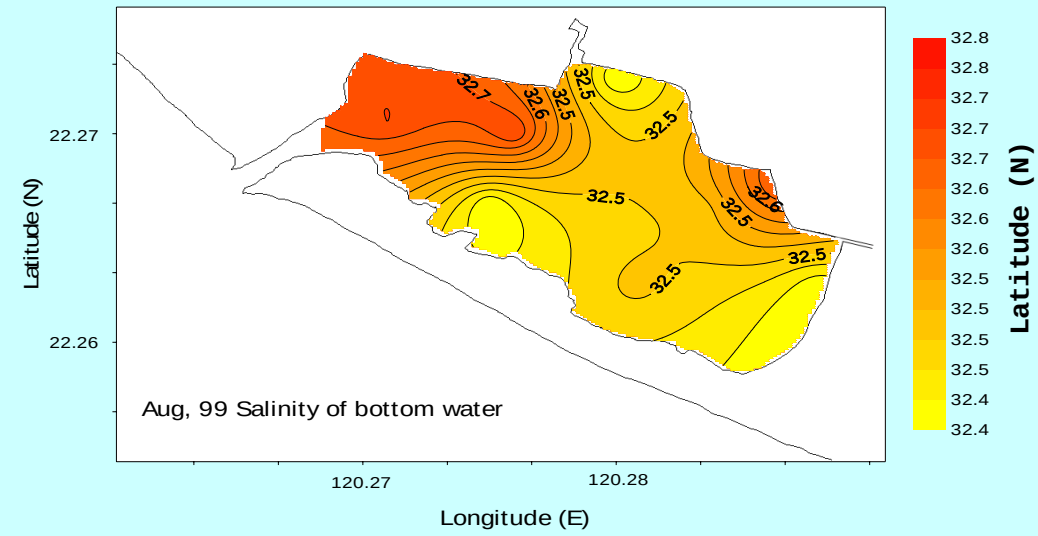

Salinity
Net precipitation ($10^3$ $m^3$ $d^{-1}$)
Surface
Bottom
Net precipitation
Temperature (°C)
pH
DO (mg $l^{-1}$)
Aug 1999
Oct
Dec
Feb 2000
Apr
Jun
Aug
Dec 2001
Jul 2002
Feb 2003
May
Aug
Nov
Jun 2004
Sep

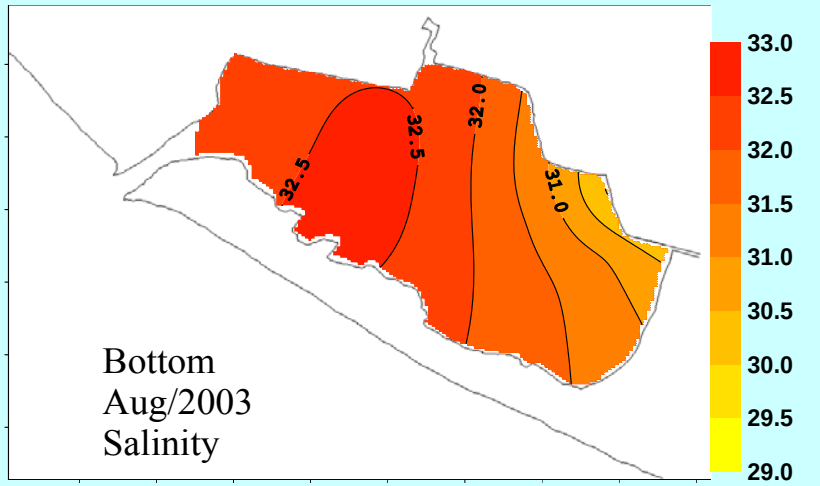
# Before (1999)



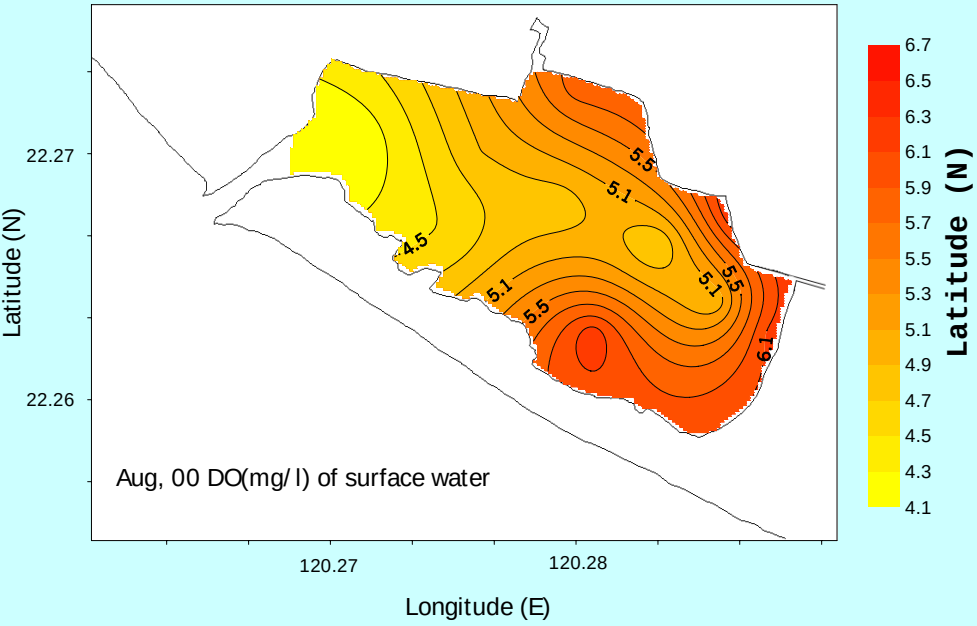

# After (2003)



# Before (2000)

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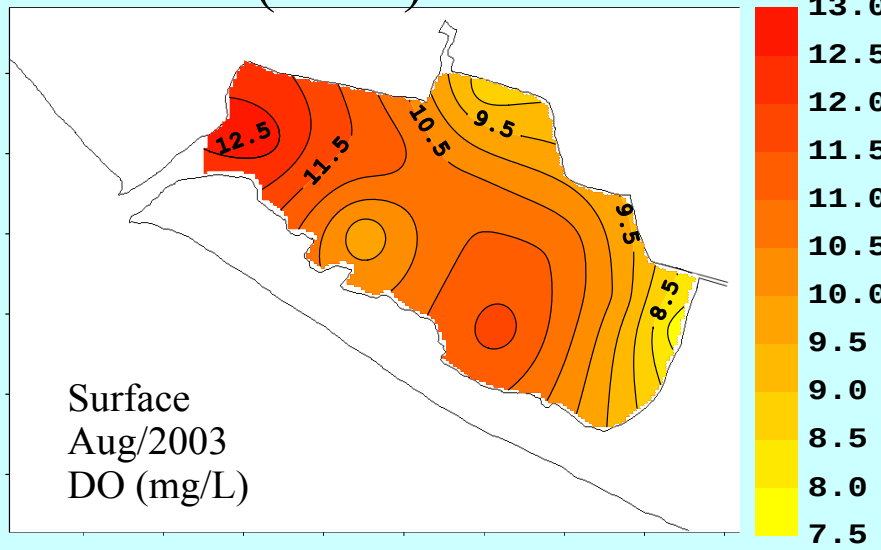


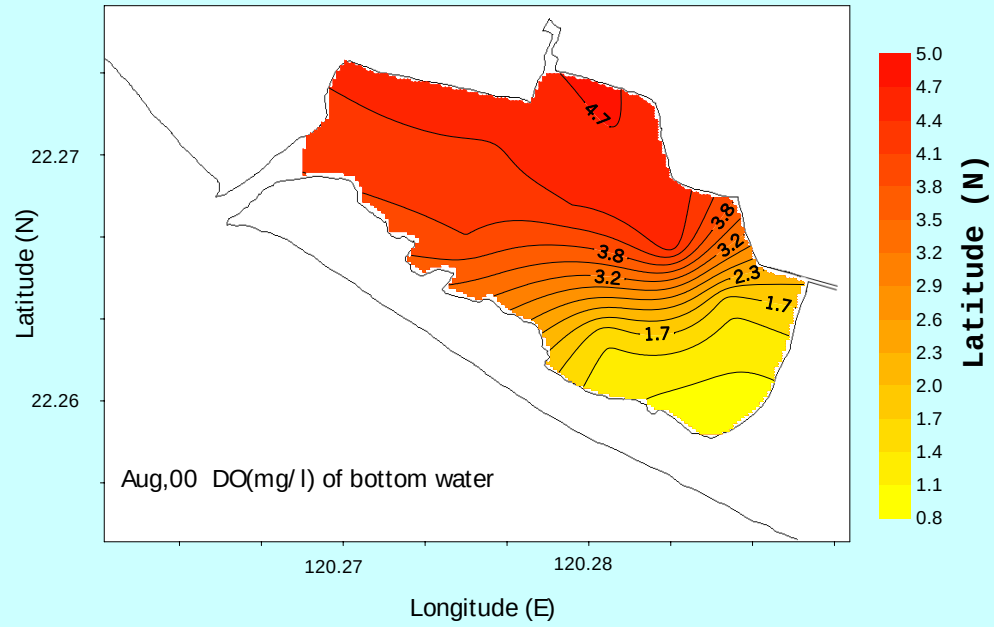


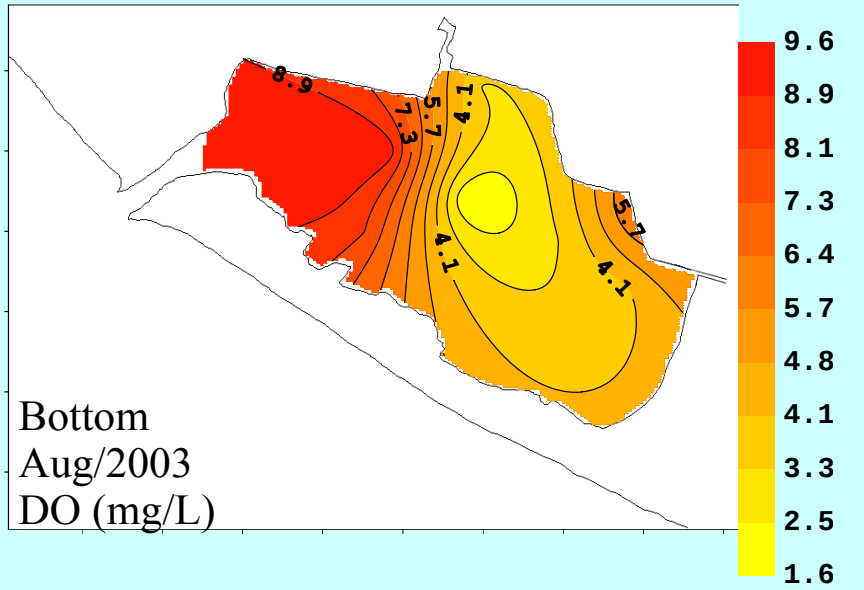

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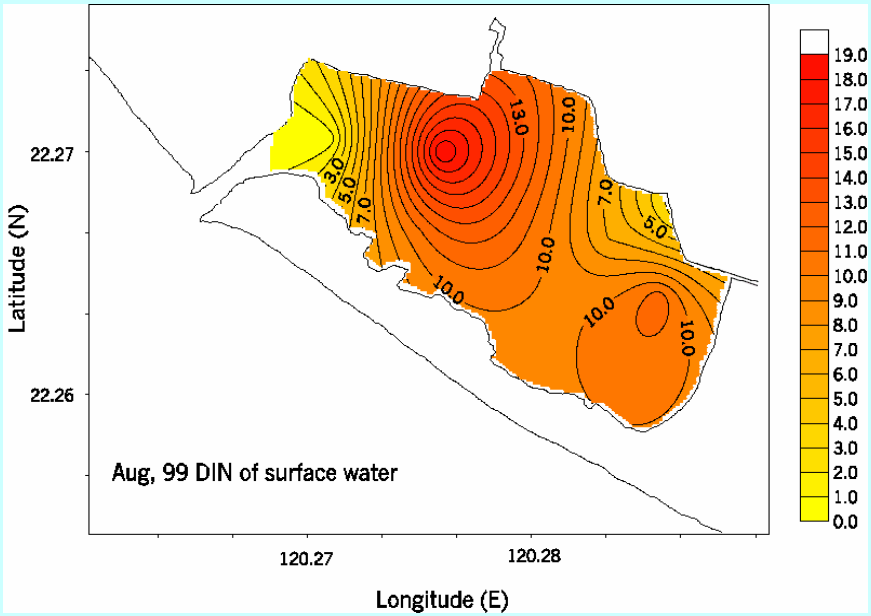


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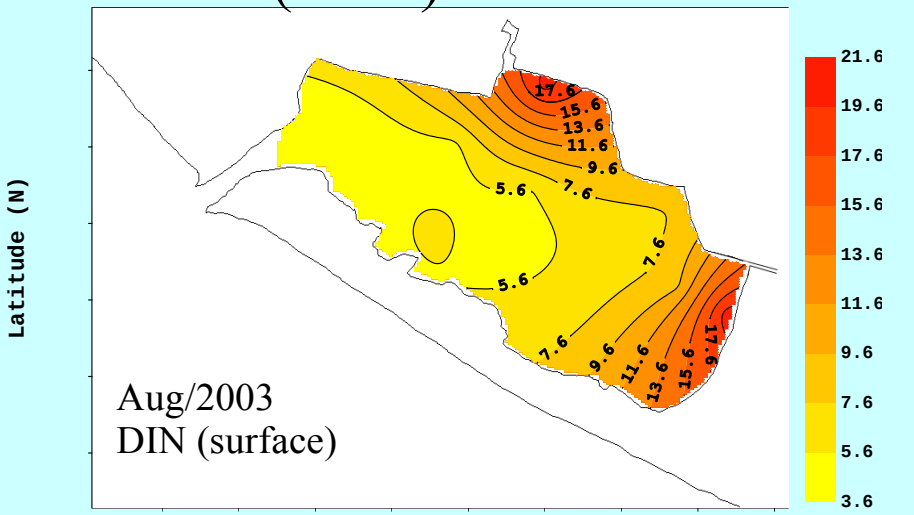
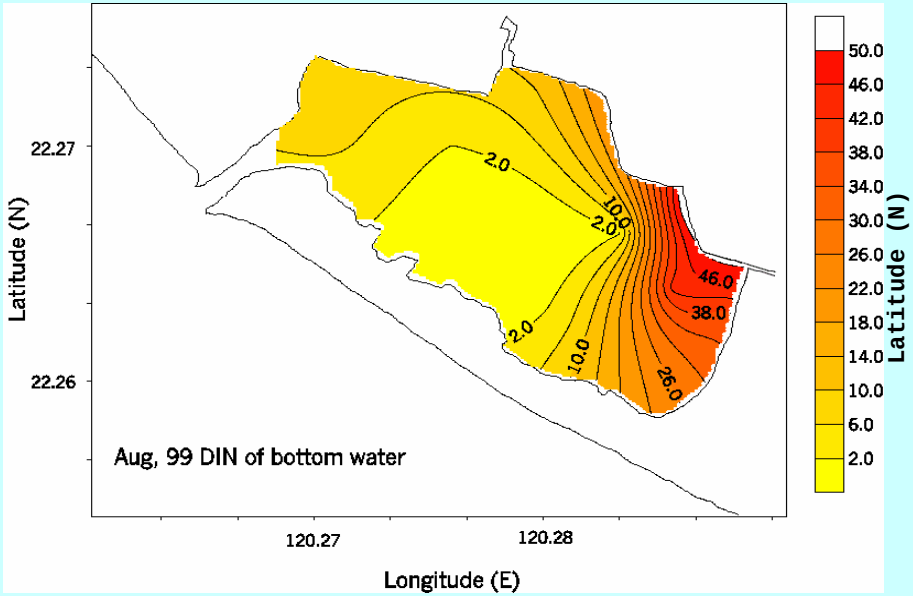
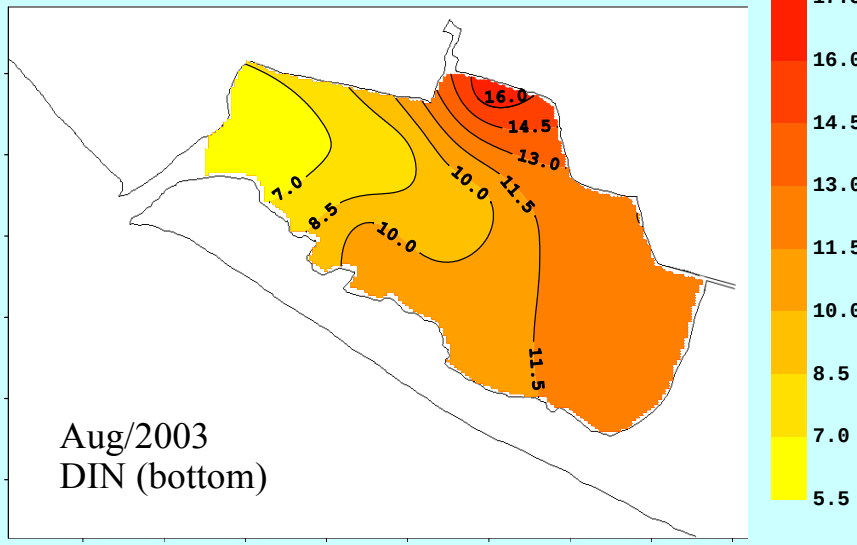
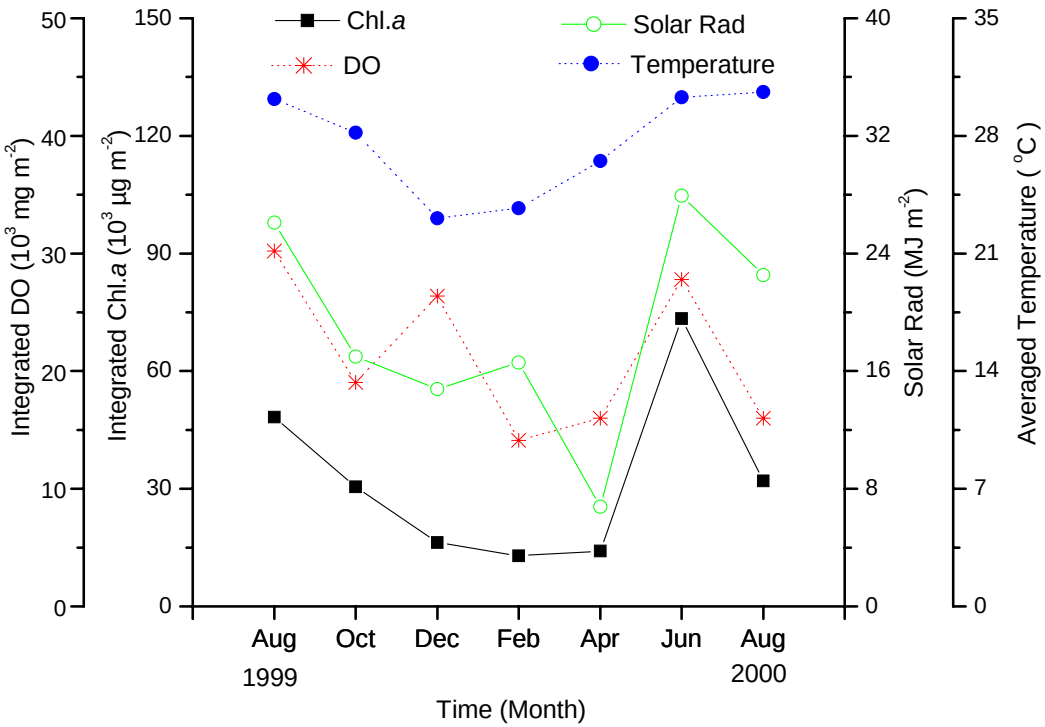
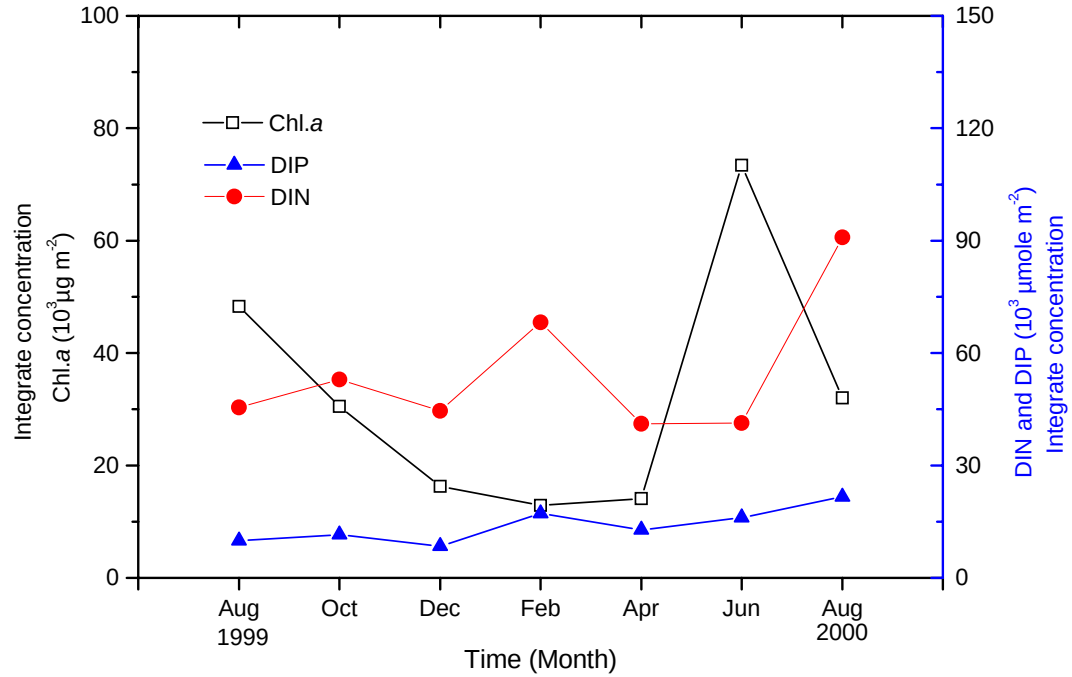


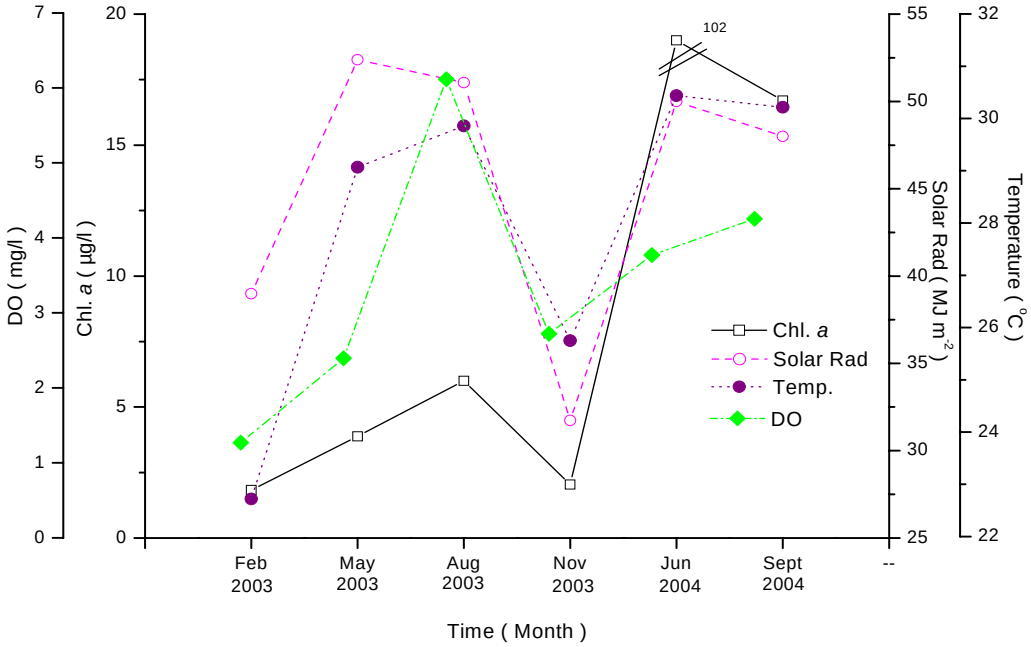



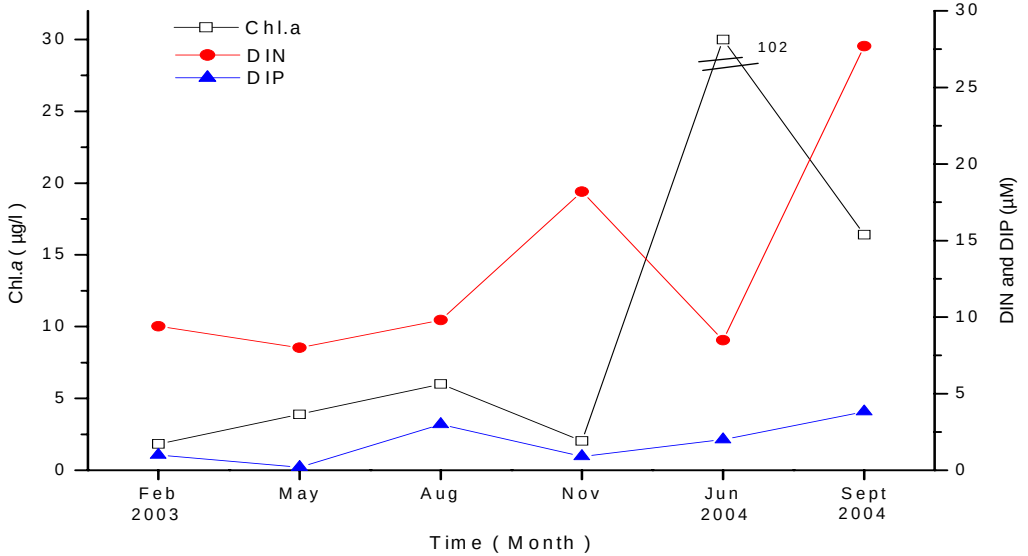
Before structure removal



# After removal

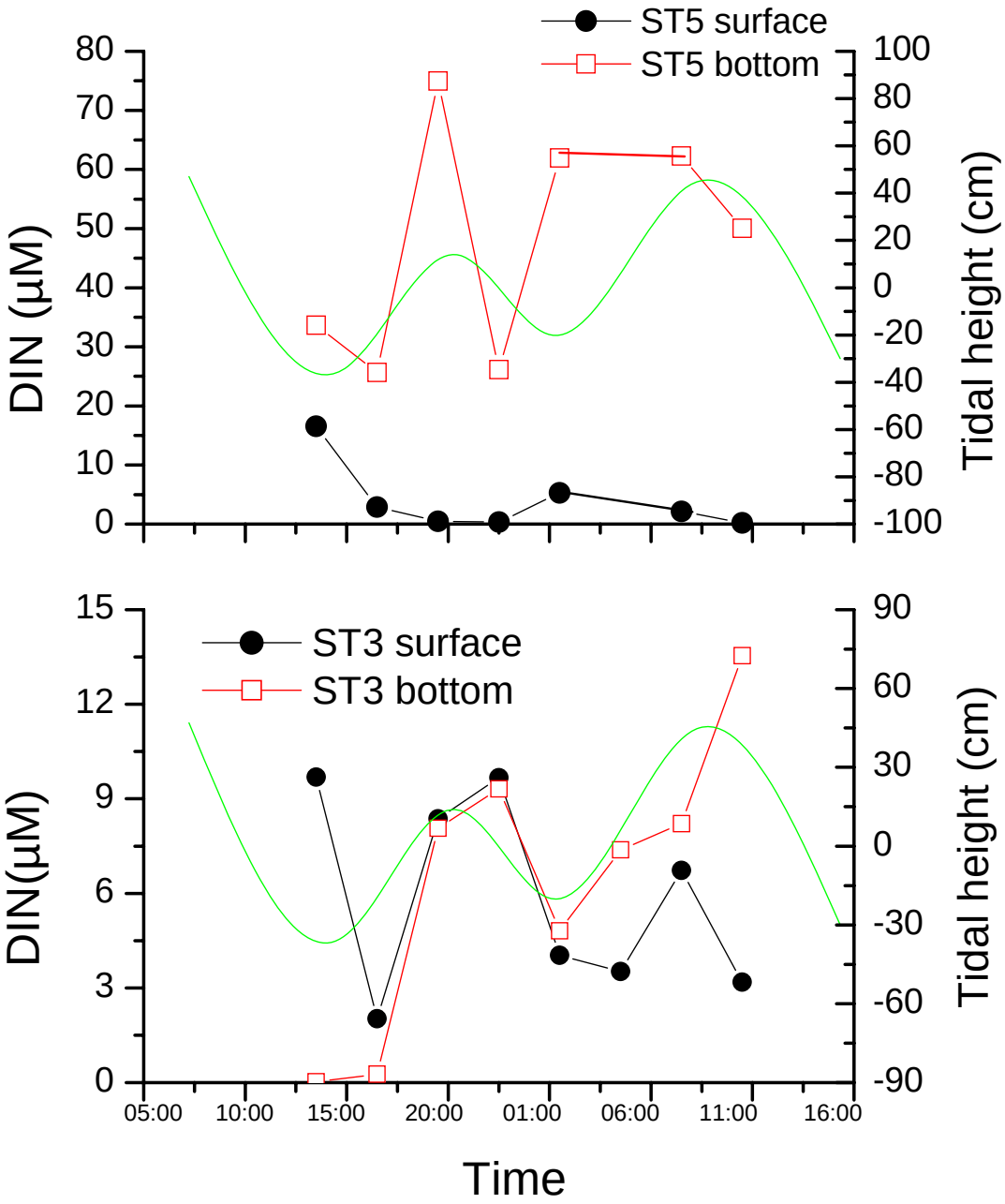


# LOICZ Biogeochemical Modelling

Nutrients

Carbon



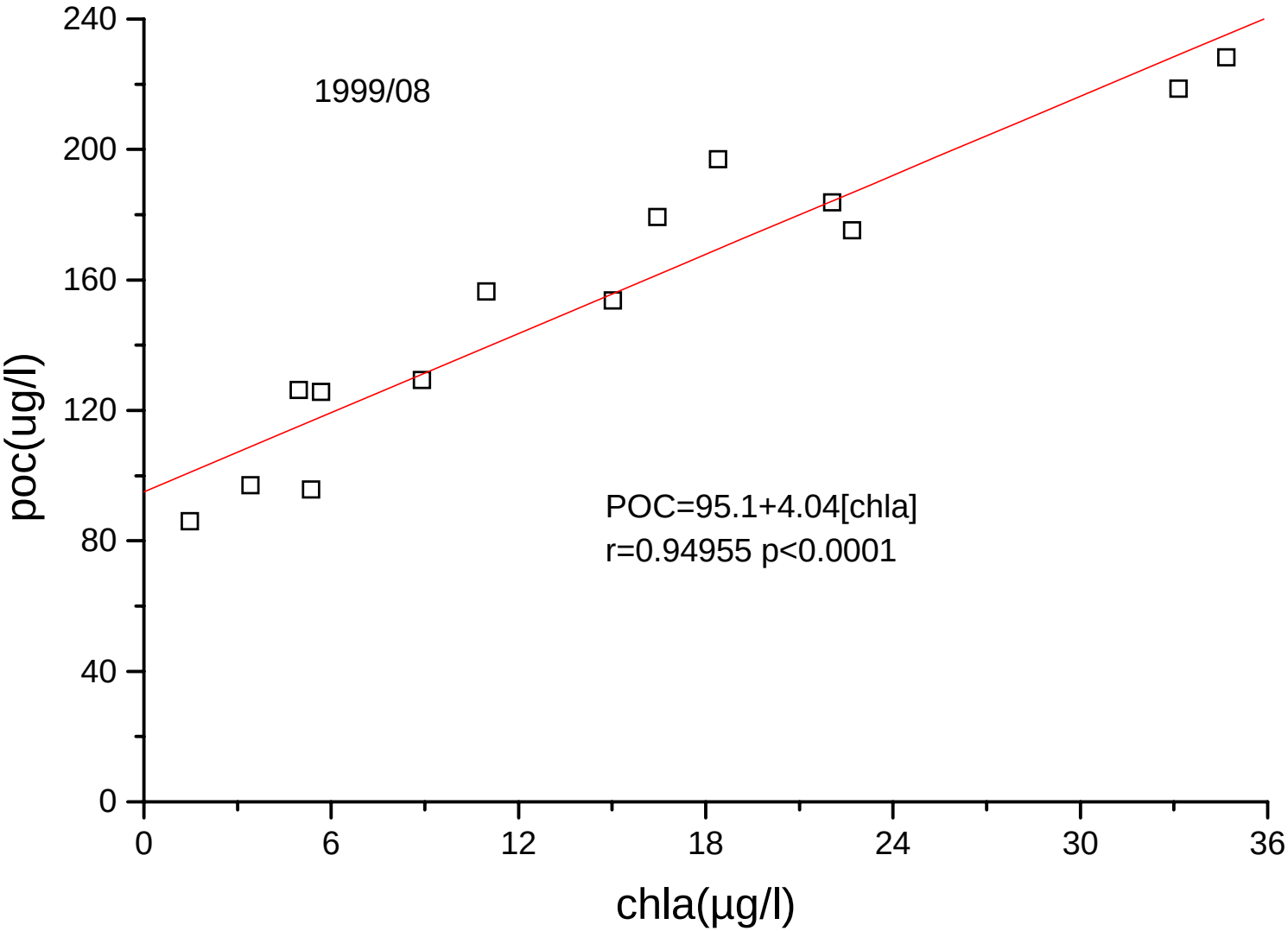

24-hr changes of DOC and POC inventories (NEP= [VxΔDOC(POC)/Δt] + output – input)

6.2 mmol C $m^{-2}$ $d^{-1}$

NEP= p – r

= -106 ΔDIP

7.1 mmol C $m^{-2}$ $d^{-1}$




Biological origin of POC: ~73%

Table 1 Temporal variability of freshwater inputs, seawater exchange and residence time

| | Sampling time | Freshwater inout ($10^3$ $m^3$ $d^{-1}$) | | Residual flow ($10^3$ $m^3$ $d^{-1}$) | Ocean salinity | Lagoon water | | |
|---|---|---|---|---|---|---|---|---|
| | | Precipitation | Evaporation | | | Salinity | Exchange rate ($10^3$ $m^3$ $d^{-1}$) | T (day) |
| Before structure removal | Aug-1999 | 90 | 22 | 213 | 33.6 | 31.3 | 1480 | 7.1 |
| | Oct-1999 | 28 | 16 | 157 | 33.8 | 31.8 | 810 | 12.4 |
| | Dec-1999 | 4 | 12 | 138 | 34.2 | 32.9 | 859 | 12.0 |
| | Feb-2000 | 4 | 12 | 137 | 34.4 | 33.3 | 770 | 13.2 |
| | Apr-2000 | 10 | 21 | 119 | 34.3 | 33.9 | 974 | 11.0 |
| | Jun-2000 | 30 | 26 | 151 | 33.7 | 31.5 | 1033 | 10.1 |
| | Aug-2000 | 93 | 18 | 423 | 32.7 | 25.4 | 968 | 8.6 |
| | Dec-2001 | 1 | 12 | 134 | 34.3 | 33.4 | 1114 | 9.3 |
| | Jul-2002 | 68 | 25 | 189 | 34.3 | 32.7 | 1803 | 5.8 |
| | Mean | 36 | 18 | 185 | 33.9 | 31.8 | 1090 | 10.0 |
| After structure removal | Feb-2003 | 2 | 17 | 130 | 34.9 | 34.4 | 1454 | 7.3 |
| | May-2003 | 8 | 28 | 125 | 35.1 | 34.6 | 2078 | 5.3 |
| | Aug-2003 | 128 | 21 | 251 | 33.5 | 30.4 | 1560 | 6.4 |
| | Nov-2003 | 10 | 15 | 140 | 34.1 | 32.7 | 1121 | 9.2 |
| | Jun -2004 | 6 | 22 | 129 | 33.6 | 32.1 | 2916 | 3.8 |
| | Sep-2004 | 143 | 22 | 267 | 33.1 | 31.3 | 2335 | 4.5 |
| | Mean | 49 | 21 | 174 | 34 | 33 | 1911 | 6.1 |

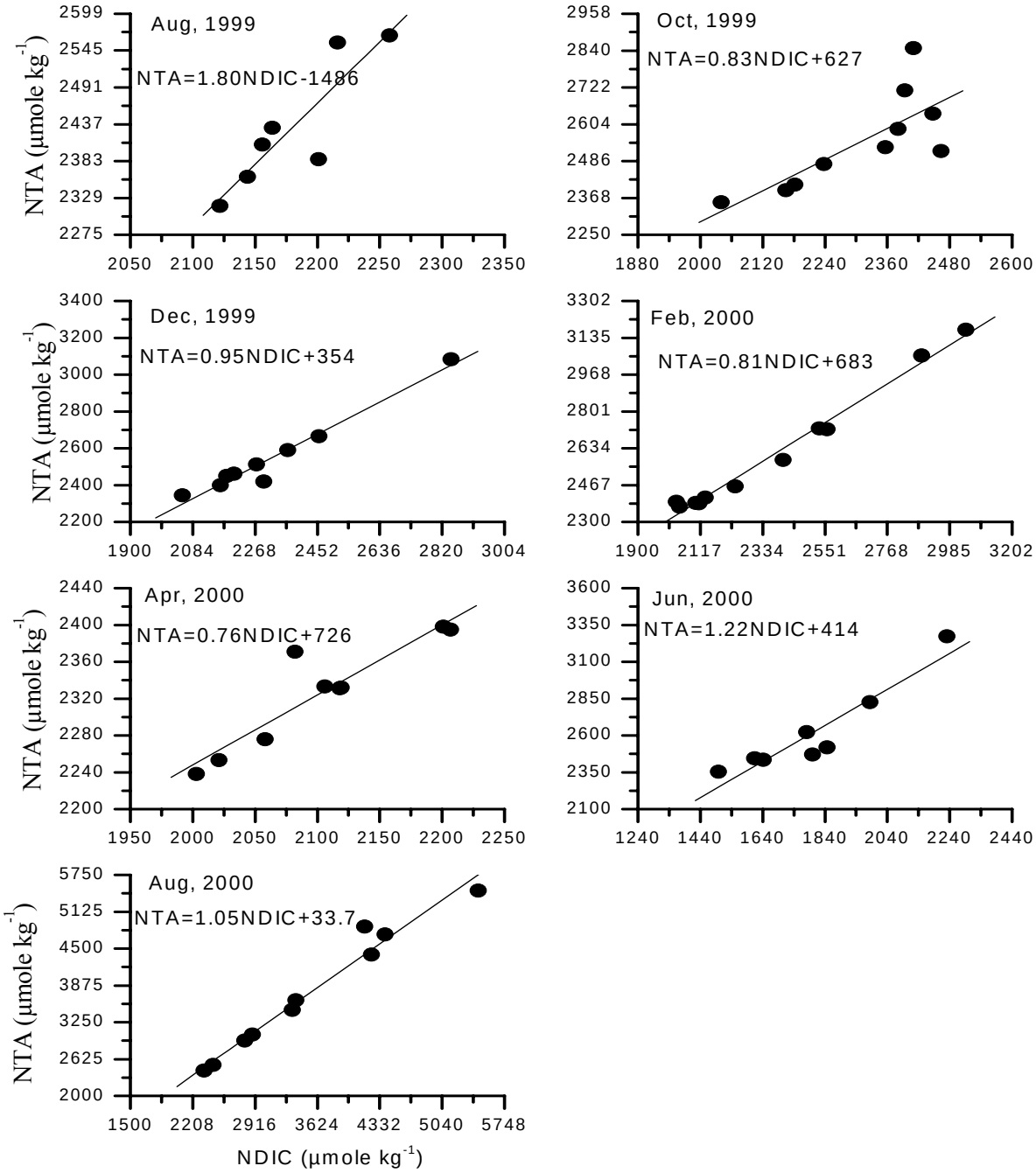

Aug, 1999
NTA=1.80NDIC-1486
Oct, 1999
NTA=0.83NDIC+627
Dec, 1999
NTA=0.95NDIC+354
Feb, 2000
NTA=0.81NDIC+683
Apr, 2000
NTA=0.76NDIC+726
Jun, 2000
NTA=1.22NDIC+414
Aug, 2000
NTA=1.05NDIC+33.7
NTA (µmole kg-1)
NDIC (µmole kg-1)

Table 2 Temporal variability of non-conservative fluxes of nutrients and carbon in the Tapong bay

| | Sampling Time | Δ DIN | Δ DON | Δ DIP | Δ DOP | Δ N | Δ P | nfix-denit | $\Delta DIC_O$ |
|---|---|---|---|---|---|---|---|---|---|
| Before structure removal | Aug-1999 | -0.58 | 3.40 | -0.06 | 0.26 | 2.82 | 0.20 | -0.4 | -6.4 |
| | Oct-1999 | -1.00 | 0.62 | -0.13 | 0.64 | -0.46 | 0.51 | -8.6 | -13.8 |
| | Dec-1999 | -1.15 | 3.28 | -0.36 | -0.32 | 2.25 | -0.68 | 13.1 | -38.2 |
| | Feb-2000 | -0.28 | 3.21 | 0.02 | -0.38 | 3.04 | -0.36 | 8.8 | 2.1 |
| | Apr-2000 | 0.92 | 1.51 | -0.02 | 0.06 | 2.52 | 0.04 | 1.9 | -2.1 |
| | Jun-2000 | -0.08 | 1.89 | -0.08 | 0.26 | 1.60 | 0.18 | -1.3 | -8.5 |
| | Aug-2000 | 2.28 | -1.53 | -0.42 | -0.25 | 0.66 | -0.67 | 11.4 | -44.5 |
| | Dec-2001 | 1.21 | - | -0.04 | - | 1.21 | -0.04 | 1.9 | -4.7 |
| | Jul-2002 | 3.74 | - | -0.22 | - | 3.74 | -0.22 | 7.3 | -23.0 |
| | mean (mmole $m^{-2}$ $d^{-1}$) | 0.56 | 1.77 | -0.15 | 0.04 | 1.93 | -0.12 | 3.8 | -15.4 |
| | mean (mole $m^{-2}$ $yr^{-1}$) | 0.21 | 0.65 | -0.05 | 0.01 | 0.70 | -0.04 | 1.4 | -5.6 |
| After structure removal | Feb-2003 | -4.90 | -5.70 | -1.20 | 0.02 | -10.60 | -1.18 | 8.35 | -127.6 |
| | May-2003 | -1.88 | 12.62 | -0.02 | -0.51 | 10.74 | -0.53 | 19.17 | -2.0 |
| | Aug-2003 | -2.05 | 6.27 | -0.26 | -1.16 | 4.22 | -1.42 | 26.94 | -26.7 |
| | Nov-2003 | -1.23 | 10.02 | -0.23 | 0.01 | 8.79 | -0.23 | 12.41 | -24.6 |
| | Jun-2004 | -3.47 | 4.14 | -0.05 | 0.48 | 0.67 | 0.43 | -6.21 | -5.6 |
| | Sep-2004 | -1.69 | 3.75 | -0.04 | -0.06 | 2.06 | -0.10 | 3.66 | -4.2 |
| | mean (mmole $m^{-2}$ $d^{-1}$) | -2.54 | 5.18 | -0.30 | -0.20 | 2.65 | -0.50 | 10.72 | -31.7 |
| | mean (mole $m^{-2}$ $yr^{-1}$) | -0.93 | 1.89 | -0.11 | -0.07 | 0.97 | -0.18 | 3.91 | -11.6 |

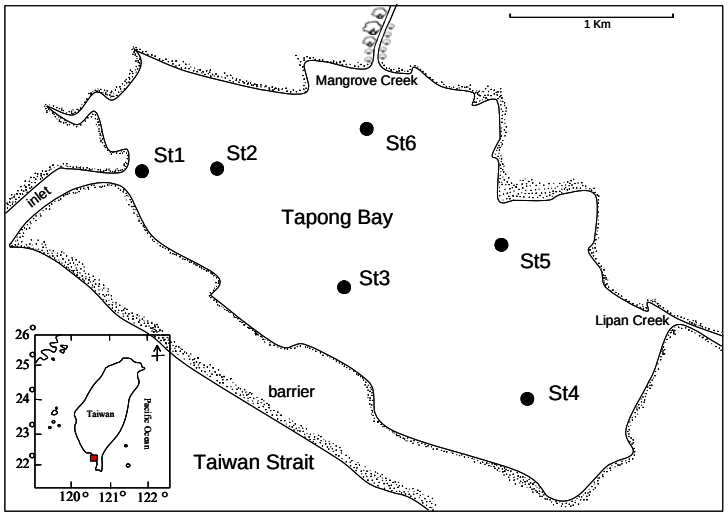
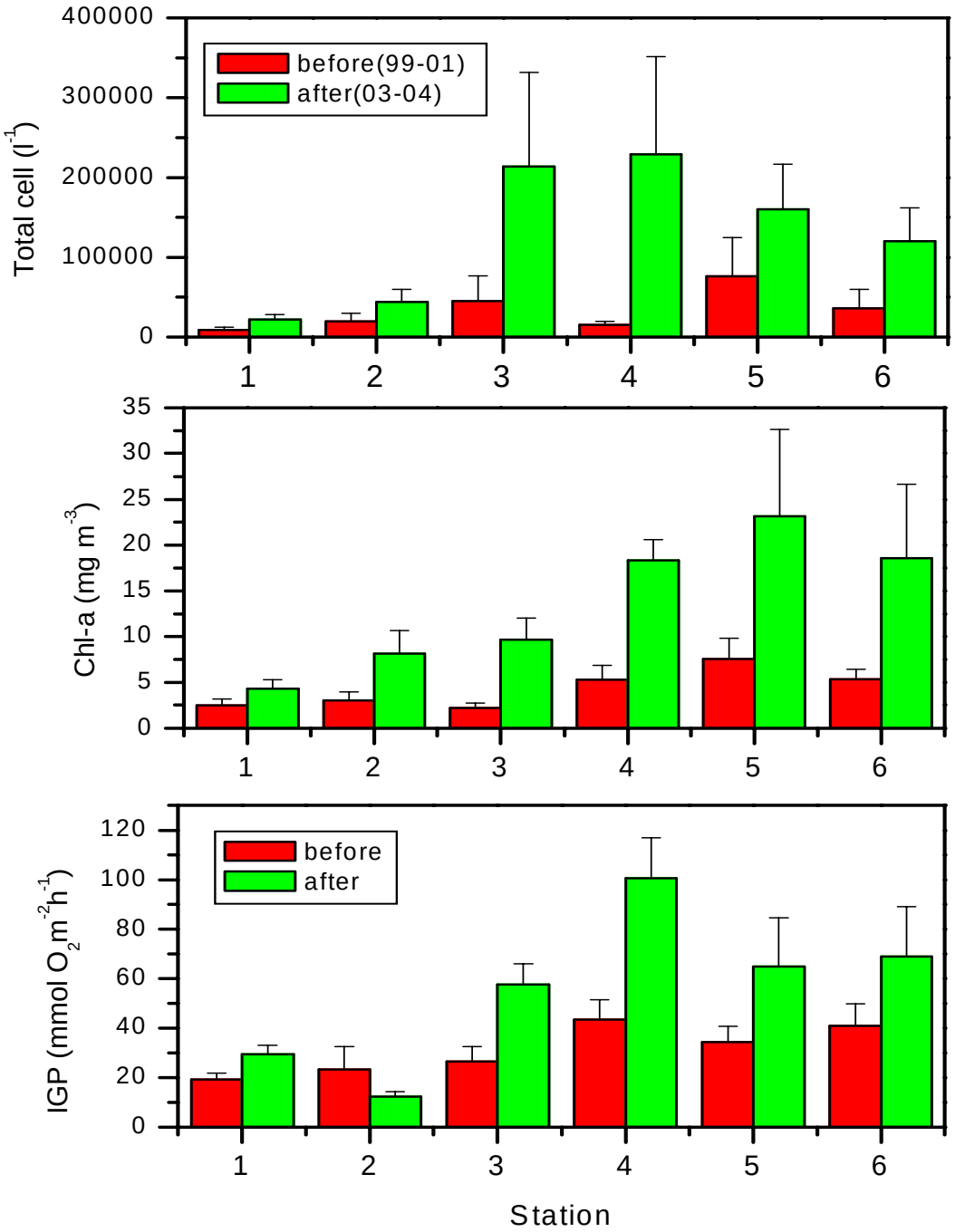



Fig. 1 Study sites of Tapong Bay and surrounding land uses



# Summary

- The exchange time of system water shifts from ~ 10 d to ~ 6d after the removal of maricultural structures
- Eutrophication still exists during warm seasons but oxygen saturation increases in surface and bottom waters after the removal of surface structures
- Nutrient distributions and speciation change significantly; generally, DIM decreases while DOM increase after the removal of surface structures
- The major controlling factors of primary productivity appear to be similar before and after the removal of surface structures
- The system remains autotrophic and net *(nfix-denit*), but both magnitudes of NEP and *(nfix-denit*) increase significantly.

Thanks

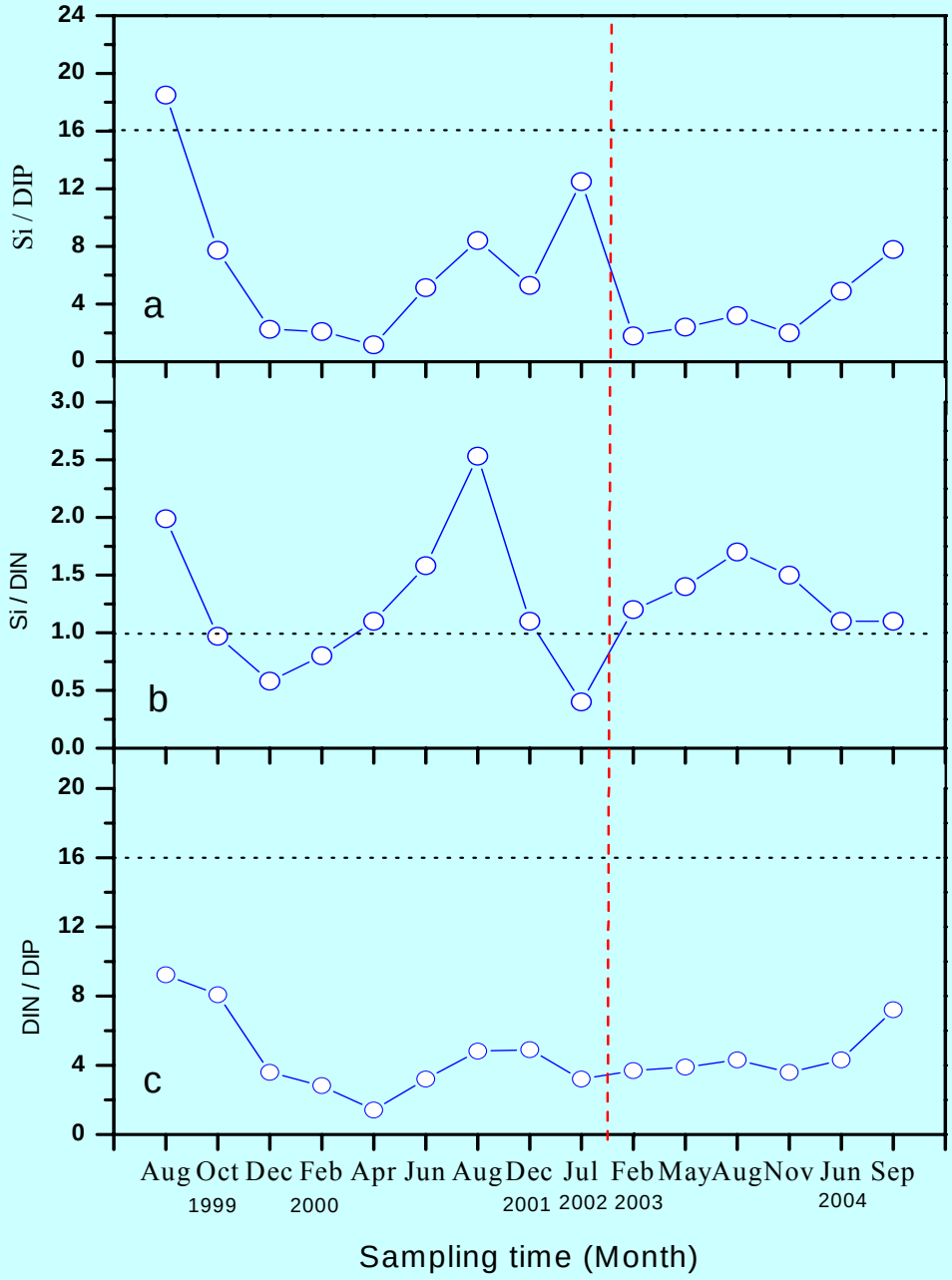
# Eutrophication

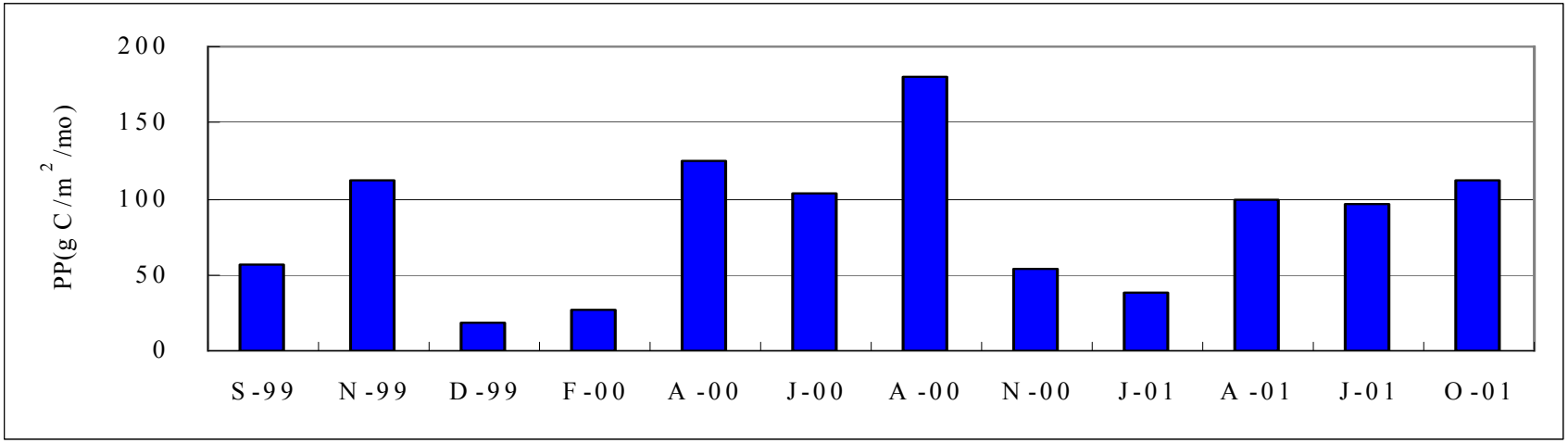
## Nixon 1995

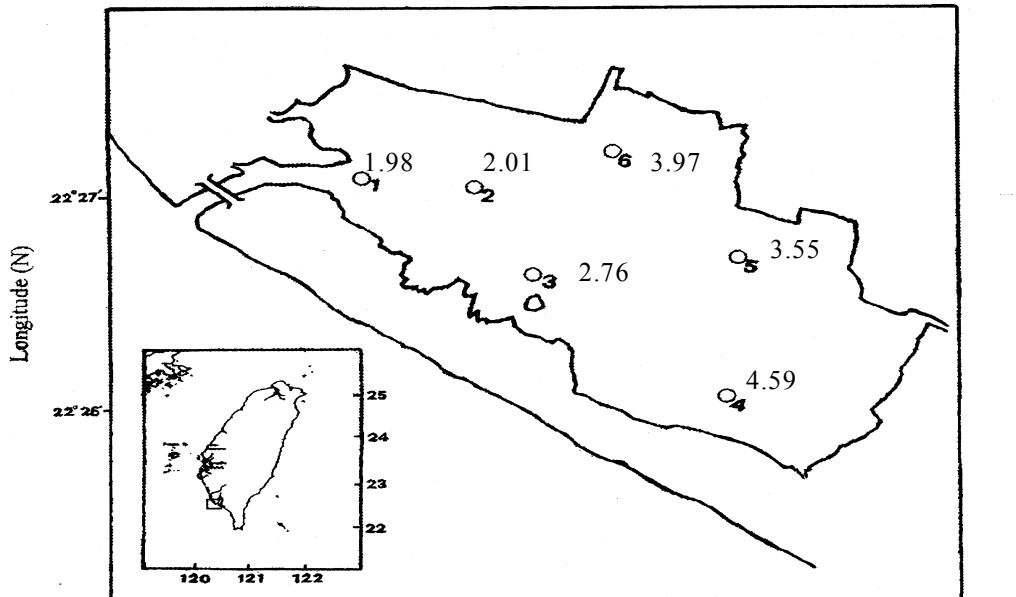
(Organic carbon input: g C $m^{-2}yr^{-1}$)

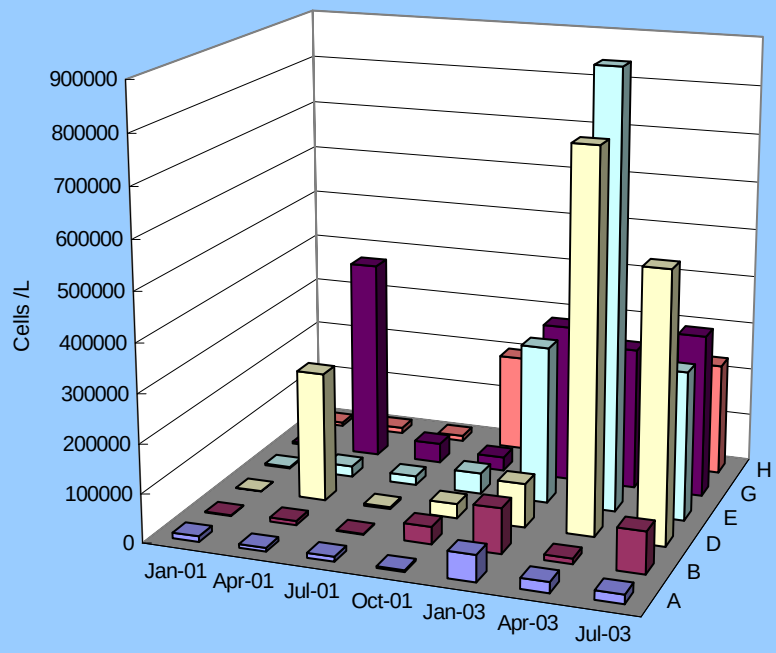
- Oligotrophic <100
- Mesotrophic 100 – 300
- Eutrophic 301 – 500
- Hypertrophic >500

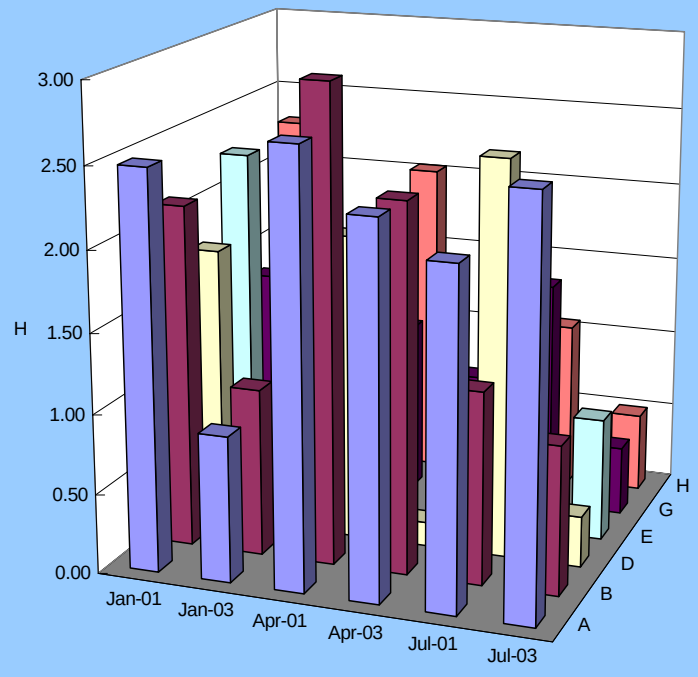
- Tapong Bay (gross production: 1066 g C $m^{-2}yr^{-1}$)

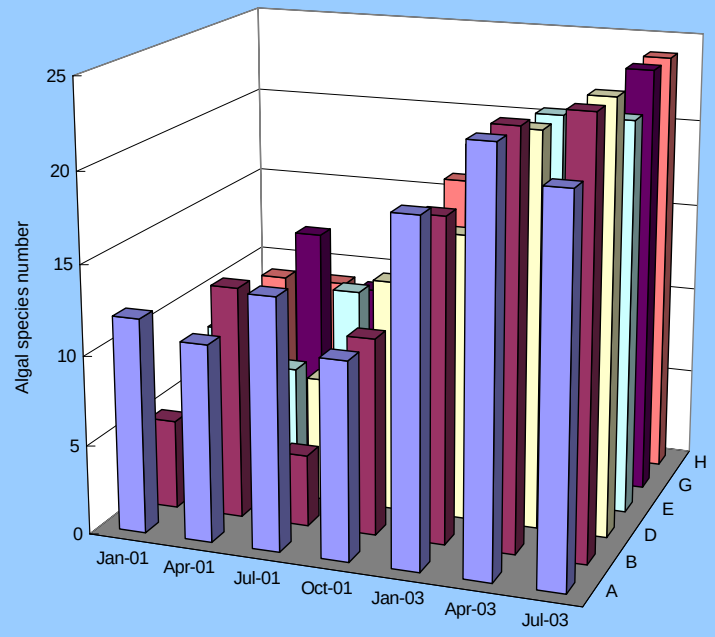

Si / DIP
a
Si / DIN
b
DIN / DIP
c
Aug Oct Dec Feb Apr Jun Aug Dec Jul Feb May Aug Nov Jun Sep
1999
2000
2001
2002
2003
2004
Sampling time (Month)


PP(g C /m 2 /mo)
200
150
100
50
0
S-99
N-99
D-99
F-00
A-00
J-00
A-00
N-00
J-01
A-01
J-01
O-01


Longitude (N)
22°27'
22°25'
1.98
2.01
3.97
2.76
3.55
4.59
O1
O2
O3
O4
O5
O6
25
24
23
22
120
121
122




2003年矽藻種類減少，渦鞭藻種類增加，總出現之藻種數2003年較2001年增加，此可能是未被牡蠣濾食所致，但因單種數量特別多，以致2003年藻種歧異度值反而降低，小於或近於1。